corn and but little can be replanted. The amount of damage can not be given with any degree of accuracy, but it is apparent that the flood destroyed the excellent prospects that had previously been entertained of harvesting the largest corn crop of the last twenty years. Below Mount Vernon, Ind., stock was removed from the bottoms, and portable property protected, so that there was no loss except the labor of replanting corn lands that had been overflowed.

The Mississippi and Missouri rivers were higher than during the preceding month, but there were no floods.

The highest and lowest water, mean stage, and monthly range at 278 river stations are given in Table VI. Hydrographs for typical points on seven principal rivers are shown on Chart V. The stations selected for charting are Keokuk, St. Louis, Memphis, Vicksburg, and New Orleans, on the Mississippi; Cincinnati and Cairo, on the Ohio; Nashville, on the Cumberland; Johnsonville, on the Tennessee; Kansas City, on the Missouri; Little Rock, on the Arkansas; and Shreveport, on the Red.—*H. C. Frankenfield, Professor of Meteorology.*

CLIMATE AND CROP SERVICE.

By Mr. JAMES BERRY, Chief of Climate and Crop Divison.

The following summaries relating to the general weather and crop conditions during May are furnished by the directors of the respective sections of the Climate and Crop Service of the Weather Bureau; they are based upon reports from cooperative observers and crop correspondents, of whom there are about 3300 and 14,000, respectively:

Alabama.—Weather favorable for growth, though rainfall generally excessive, retarding work. Cotton made satisfactory stands and fairly good growth, though grass increased so rapidly that some fields were abandoned, labor scarce, some damage by lice; squares appeared on early planted during last week. Corn and minor crops advanced well; some corn damaged by worms and overflow; forward corn silking at close of month. Early peaches were ripening at end of month, and oat and wheat harvest active, wheat indicating light yield, oats satisfactory.—*F. P. Chaffee.*

Arizona.—Temperature greatly deficient. There was a generous supply of precipitation over the northern division, while over the southern and western divisions the shortage was extremely large. Phenomenally heavy snowfall 2d to 6th. Wheat, barley, and oat harvest general and garden truck, apricots, and figs plentiful throughout the central and southern divisions; yields large, quality excellent. Rapid progress in farm work in north division. Corn planting finished, stands good. Large shipments of berries, melons, and apricots. Mountains and streams contained an overabundance of water. Stock healthy. Second alfalfa cutting on the 25th.—*L. N. Jesunofsky.*

Arkansas.—The temperature was moderate and the rainfall unusually heavy. Owing to unfavorable weather cotton and corn planting was not completed during the month. Cotton came up to a fair stand, but made slow progress owing to lack of cultivation and to too much moisture. Chopping became fairly general by the close of the month. Corn was a fair stand, but was small and had poor color. Minor crops and fruits did well, although there was considerable complaint of apples dropping.—*Edward B. Richards.*

California.—Abnormally cool and generally cloudy weather during the greater part of the month retarded crop growth. Severe frosts caused some damage to deciduous fruits in the foothill districts, and in some sections new hay and early fruits were injured by heavy rain and hail. The rainfall was greatly in excess of the average in the Sacramento and San Joaquin valleys, and the temperature for the State was 3.6° below the normal. High winds and thunderstorms were of frequent occurrence.—*Alexander G. McAdie.*

Colorado.—Except in the southwestern counties during the last decade, conditions were generally unfavorable. Considerable damage by hailstorms occurred in localities on the eastern slope. At the close of the month seeding and planting were nearly finished, except in localities east of the mountains, where some sugar beets, potatoes, and corn remained to be planted, but early plantings were up; wheat, oats, rye, alfalfa, and grasses were doing well, and fruit prospects good.—*F. H. Brandenburg.*

Florida.—The month averaged warmer and wetter than the normal. Work advanced very well, except during a few days when it was retarded by too frequent rain. The bulk of the cotton crop was chopped out and and the early planting took on some fruit. Some replanting was done on lowlands. The corn crop promised to be an excellent one. Citrus trees were vigorous. Cane, tobacco, and minor crops did well. Shipments of peaches, pineapples, and melons began.—*A. J. Mitchell.*

Georgia.—Month warm; too wet for farm work. Cotton planting completed by 15th; stand excellent; fields became very grassy, some abandoned; plants were generally healthy and made good growth where worked; some injury by lice; labor scarce. Corn progressed nicely; received insufficient cultivation; some injured by bud worms; laying by began south; late planting unfinished. Wheat yield shortened by rust. Oats generally fine. Early peaches began to ripen south, good yield, excellent quality; crop poor north.—*J. B. Marbury.*

Hawaii.—See Addendum et Corrigenda, on a subsequent page.

Idaho.—Cool weather retarded the growth of vegetation and some damage to fruit and tender vegetables resulted from frost, but at the close of the month most crops were in good condition. Ranges were unusually good and stock made excellent gains. An unusually heavy shower occurred in the mountains back of the city of Boise on the evening of the 27th, flooding a portion of the city for several hours; only slight damage resulted.—*Edward L. Wells.*

Illinois.—By the 15th corn was mostly planted in the central district. Wheat and rye were heading out. Clover was in bloom in the southern district. At the end of the month the bulk of the corn crop was in the ground in the region of heaviest production. Wheat, oats, rye, grasses, and potatoes were promising. Tree fruit, except peaches, gave promise of a fair yield, although much complaint was made of fruit falling.—*Wm. G. Burns.*

Indiana.—Owing to excess of moisture in the ground sowing oats was not finished until about the middle of the month and much corn ground had not been seeded at its close. Oats came up to a good stand and early corn did fairly well. Wheat, rye, clover, and timothy continued promising. Transplanting tomatoes and tobacco progressed satisfactorily the latter part of month. Field onions suffered from flooding. Apples, peaches, pears, and plums promised fair crops, cherries light; grapes and other small fruit good.—*W. T. Blythe.*

Iowa.—Month cooler than usual, with excessive rainfall in northern half of State; planting operations delayed and germination of corn retarded, conditions necessitating more than usual replanting. At close of month corn had made better stand than was previously anticipated and fields were being cultivated. Month was favorable for growth of wheat, oats, barley, rye, potatoes, and garden truck. Apples were generally promising, but cherries and plums were light; grapes and berry crop very good.—*John R. Sage.*

Kansas.—Wheat was heading in the southern counties the first week and in the northern the last week of the month. Corn planting was nearly finished the first week, much of it was up, and cultivation had begun. Oats improved slowly, began heading in the southern counties the third week and in the northern the last week. Grass improved. Alfalfa cutting began in southern counties first week, in northern by 15th, was damaged by frequent showers. Apples poor prospects in some counties, very promising in others.—*T. B. Jennings.*

Kentucky.—Temperature averaged slightly above normal, except in the south-central portion. Frost in the extreme northern counties on the 1st did no damage. Month generally favorable, but heavy rains caused damage in some localities. Wheat made excellent progress and condition was satisfactory in most sections. Oats, rye, and grasses were generally excellent. Potatoes grew nicely; tobacco was mostly set and looked vigorous. Corn planted, except where flooded, and mostly cultivated. Fruit dropping somewhat, but promised fair crop.—*F. J. Walz.*

Louisiana.—Favorable weather prevailed generally during early part of month, but frequent showers and occasionally heavy rains during latter half materially interfered with farming operations. The cotton crop was generally two to four weeks late, and planting continued in some sections; the bulk of the crop was badly in the grass at close of month and some lowland had been abandoned. The cane crop made good growth. Rice seeding progressed slowly and the crop was very backward. Corn suffered from too much rain, which prevented proper cultivation. Early corn was being laid by at close of month. Truck gardens yielded well.—*I. M. Cline.*

Maryland and Delaware.—Warm and droughty first half; good rains middle of month, followed by cool weather. Wheat made good heads. Oats had good stand and color, but were very backward. Corn was retarded by cool and dry weather and seriously devastated by cutworms. Grasses were short. Apples and cherries about average; pears below average; peaches light. Strawberries of fine quality were abundant. Other small fruits budded profusely. Little tobacco was set out, but plants were plentiful and thrifty. Gardens grew slowly.—*E. D. Emigh.*

Michigan.—The cool, wet weather of May, while generally favorable to wheat, rye, and meadows, interfered with planting and growth of corn, potatoes, and early beans, and retarded the growth of oats and barley. Continued wet weather blasted some fruit blossoms, especially cherries. Germination was slow, but fairly good. At close of month corn and sugar beet seeding was fairly well advanced, and early potatoes mostly planted. Wheat, rye, and meadows were in very promising condition at the end of the month.—*C. F. Schneider.*

Minnesota.—Wet weather until the 18th, and showery thereafter. Lowlands flooded and farm work hindered. Light frost 25th and 26th.

Flax and barley seeding all the month. Corn and potato planting nearing completion by end of month, and early corn, potatoes, and flax coming up by 20th. Spring wheat, oats, and barley doing well all month, and stooling nicely, but all growth was slow much of month. Rye heading by 20th. Clover and timothy promised well.—*T. S. Outram.*

Mississippi.—Planting was much hindered by frequent and heavy rains north, especially on lowlands, but generally made fair progress south. Good stands of cotton were secured and by the close of the month chopping was well advanced and cultivation was in progress, but many fields remained very grassy. Labor was scarce. Early corn was generally in fair condition; much corn remained to be planted on lowlands. Oats were promising and harvest began south. Sugar cane, potatoes, gardens, and pastures did well. The fruit outlook was poor to fair.—*W. S. Belden.*

Missouri.—The month of May was generally favorable for crop growth and cultivation. Corn planting was practically completed at the close of the month; considerable replanting was necessary, owing to poor germination; growth was satisfactory, although not vigorous, the nights being rather too cool for best results. Wheat was heading and blooming and promised an average yield. Oats, potatoes, and all minor crops were satisfactory.—*George Reeder.*

Montana.—Only about eight days with temperature above normal. Precipitation not up to normal, but State average greater than any of eighteen preceding months. Wheat and oats a good stand and made about a normal growth. Range grass was plentiful during the latter part of the month and cattle and sheep gained rapidly. Lambing operations were very successful. Alfalfa, potatoes, and fruits made slow progress, but promised well, and no material damage resulted from frost.—*R. F. Young.*

Nebraska.—Winter wheat made excellent growth and continued in good condition, except in a few places where the Hessian fly damaged the crop slightly. Oats made only a fair growth. Potatoes, alfalfa, and grass made especially good growth. Corn planting progressed slowly until the middle of the month, but was about finished by the 25th. Early planted corn came up poorly; this, and damage from heavy rain, made an unusual amount of replanting necessary.—*G. A. Loveland.*

Nevada.—The month was cooler than the average May, with precipitation slightly above normal. Frosts occurred frequently, doing considerable damage to fruit buds and early vegetables. Weather conditions were generally unfavorable for rapid growth of crops. Range feed was the best in years and stock of all kinds gained rapidly in flesh. Irrigation water for crop needs was generally plentiful in most districts.—*J. H. Smith.*

New England.—The month as a whole was cool and dry, with temperature and precipitation below normal at nearly all stations. Frosts were of general occurrence on the 24th, and snow fell in many northern sections on the 1st, amounting in a few instances to two inches. The unfavorable weather conditions retarded crops and in many fields planted seeds failed to germinate. Excepting the hay crop, which will be short, the drought caused little damage beyond delaying growth.—*J. W. Smith.*

New Jersey.—The month was very dry and the rainfall that occurred was quite unevenly distributed. The last killing frost occurred on the 2d, doing considerable injury to tender vegetation, but very little to orchard fruit trees. Wheat and rye headed well, but the straw was very short; grass and clover crops suffered greatly from drought.—*Edward W. McGann.*

New Mexico.—Dry, cool month, but soil conditions good. Moisture generally abundant. Streams high and some damage by floods, especially in middle and lower Rio Grande Valley. Field crops, gardens, fruits, forage crops, range grasses, and late seeding and planting made good progress. First cutting of alfalfa continued throughout the month, with heavy yield. Stock losses confined to northeast counties during first decade, thereafter steady and rapid improvement. Very large percentage of increase in lambs, but light in calves. Shearing rapidly completed.—*Charles E. Linney.*

New York.—Weather favorable for farm work. Small grains and grass did fairly well, but nights too cool for other crops. More rain needed in some localities. Light frosts were frequent. Killing frosts reported in some localities 21st to 24th, damage not extensive. Apples bloomed well, with the exception of Baldwins. Corn and potatoes were planted and early fields were coming up during the latter part of the month. Gardens were made, but growth of all vegetables was slow.—*H. B. Hersey.*

North Carolina.—The temperature was above normal during May, except during the period from the 18th to 27th, when low temperatures at night severely checked the growth of vegetation. The rainfall was very excessive, and there were many severe local wind and hail storms, with minor damage to crops. Planting was much delayed and crops could not be properly cultivated. Much corn and cotton were planted and came up to good stands, but stands of corn were impaired by ravages of cutworms. The bulk of the tobacco crop was transplanted and did well. Wheat, rye, winter and spring oats, clover, and grasses made vigorous growth. Fruit suffered from blight.—*C. F. von Herrmann.*

North Dakota.—The month was cooler than the average, with excessive precipitation, heavy rain over a greater portion of the State causing more or less injury to crops, especially on low land. Killing frosts also cut down some early sown grain and injured fruit buds, and high winds cut down tender vegetation and blew out and uncovered seed. With ample moisture and warmer weather at the close of the month, all vegetation greatly improved.—*F. J. Rupert.*

Ohio.—Excessive rains during first week caused considerable damage by washing and flooding, and frost on 24th did some damage in northeast; otherwise, generally favorable weather prevailed. Corn planting and tobacco setting progressed rapidly. Corn was small and uneven and of poor color. Wheat, oats, rye, meadows, clover, pastures, and early potatoes improving. Wheat heading. Apples, pears, and plums less promising. Berries improving.—*J. Warren Smith.*

Oklahoma and Indian Territories.—Tornadoes, hailstorms, and excessive precipitation in localities caused great loss of life and destruction to property. Wheat, oats, rye, spelt, and barley headed well and were in fair to good condition. Corn was weedy and needed cultivation, but did well. Cotton up to poor to good stands and being chopped, some damage by worms, rotting, and overflow. Minor crops, potatoes, gardens, grass, stock, and fruit did well.—*C. M. Strong.*

Oregon.—The month was cool and cloudy; there was plenty of rain at opportune times, but the lack of warm, sunshiny weather retarded growth. Frosts considerably damaged early fruit and tender vegetables. Barley, rye, and fall wheat headed nicely. Spring wheat and oats grew slowly. Hops came up very unevenly. Grass grew luxuriantly and there was plenty of feed for stock. Gardens, potatoes, corn, sugar beets, field onions, and beans made slow growth.—*A. B. Wollaber.*

Pennsylvania.—Damaging frosts in nearly all sections 21st to 24th, inclusive; tender vegetation and orchard and vine fruits materially injured in many localities. Droughty conditions retarded germination of late planted corn and potatoes. Wheat and rye were heading short, but stand was generally good. Tobacco thrifty and of good color. Early corn under cultivation, with cutworms becoming numerous and doing severe damage. Buckwheat land being prepared. All crops, especially meadows and pastures, badly in need of ample moisture.—*T. F. Townsend.*

Porto Rico.—Dry weather prevailed throughout the southern division; elsewhere the rainfall was equal to or in excess of requirements. Cane cutting continued, with but little interruption; crop nearly finished, yield generally good. Young canes looked promising. Coffee blossomed a second and third time in the highlands; prospects for coming crop good. Cane, rice, and small crops planted. Cotton and tobacco harvested. Pastures needed a good soaking rain in the south. Pineapples and mangoes plentiful and some alligator pears marketed. Small crops generally abundant, although some loss of beans and corn in the southwest.—*E. C. Thompson.*

South Carolina.—The temperature was at times too low for the satisfactory development of cotton, but was generally favorable. The precipitation was excessive over the larger portion, the rains having been too frequent, hindering the preparation, planting, and cultivation of lands, thus permitting fields to become foul. Where proper cultivation was practicable, corn and cotton developed favorably. Wheat and oats began to ripen, and some were cut. Fruits, rice, and gardens improved, but tobacco was hurt by excessive precipitation.—*J. W. Bauer.*

South Dakota.—Cool month, excess in precipitation benefited small grains and grasses, but retarded field work and made some lowlands too wet. Wheat, oats, barley, rye, and spelt did well, but some scattered fields of wheat and oats were thin. Corn planting was nearly finished, but germination was slow, and poor seed necessitated some replanting. Flax sowing and potato planting advanced favorably. Grass did well, affording good pasturage by the 20th. Storms early in month caused considerable loss of range stock. Frost injured some fruit.—*S. W. Glenn.*

Tennessee.—May was generally favorable for farm work, which progressed well, except when hindered by the rains, which fell at frequent intervals. Corn and cotton made fair growth; the cool nights were detrimental to cotton. Tobacco setting progressed well to completion under the favorable conditions. The rains caused rust to develop to a serious extent in wheat and greatly lessened the prospective yield. Oats promised a fine yield. Potatoes and other minor crops and garden products made good progress in growth and development. Fruit prospects continued poor.—*H. C. Bate.*

Texas.—May was generally warm. Showers occurred over northern and central portions during most of the month, causing damage by flooding and washing crops and delaying farm work. In the south there was less rainfall, and crops generally did well. Cotton planting and cultivation were delayed in central and northern counties, and the crop was not promising at the end of the month. In the south the crop did well, but the boll weevil made its appearance. Corn and grain suffered. Other crops did fairly well.—*M. E. Blystone.*

Utah.—Temperatures were about 5° daily below the normal, and precipitation was considerably above. Freezing temperatures, which were frequent around the 10th, were not generally injurious. Alfalfa was maturing a fair first crop, and was being harvested in the southern portion. Corn, potatoes, and beets were planted and were coming up in early fields. Fall grain was heading and all grain was doing well. The fruit outlook was good, though the peach crop was dwarfed by early frost. The range was good and stock thriving.—*R. J. Hyatt.*

Virginia.—The temperatures were variable, but on the whole were well suited to crop progress, while precipation was ample and well dis-

SUMMARY OF TEMPERATURE AND PRECIPITATION BY SECTIONS, MAY, 1905.

In the following table are given, for the various sections of the Climate and Crop Service of the Weather Bureau, the average temperature and rainfall, the stations reporting the highest and lowest temperatures with dates of occurrence, the stations reporting greatest and least monthly precipitation, and other data, as indicated by the several headings.

The mean temperatures for each section, the highest and lowest temperatures, the average precipitation, and the greatest and least monthly amounts are found by using all trustworthy records available.

The mean departures from normal temperature and precipitation are based only on records from stations that have ten or more years of observation. Of course the number of such records is smaller than the total number of stations.

Section.	Temperature—in degrees Fahrenheit.							Precipitation—in inches and hundredths.					
	Section average.	Departure from the normal.	Monthly extremes.					Section average.	Departure from the normal.	Greatest monthly.		Least monthly.	
			Station.	Highest.	Date.	Station.	Lowest.	Date.			Station.	Amount.	Station.	Amount.
Alabama	74.2	+ 2.7	Thomasville	99	29	Riverton	44	12	5.51	+2.10	Montgomery	9.10	Tuskegee	1.67
						Scottsboro	44	18						
Arizona	65.5	— 5.0	4 stations	110	3 dates	Flagstaff (a), Williams.	20	11	0.20	—0.13	Flagstaff (b)	1.88	22 stations	0.00
Arkansas	70.7	+ 1.1	Jonesboro	98	31	Pond	40	17	9.57	+4.64	Howe	23.50	Fort Smith	4.92
			Osceola	98	29									
California	59.6	— 3.6	Volcano Springs	111	15	Bodie	5	10	2.18	+1.02	Bowman's Dam	7.25	7 stations	0.00
Colorado	49.9	— 2.7	Delta	90	31	Silverton	0	11	2.15	+0.12	Fort Collins	5.35	Saguache	0.10
			Las Animas	90	29	Antelope Springs	0	11						
Florida	78.7	+ 3.0	Marianna	101	12	Brooksville	48	2	5.56	+1.75	Wausau	13.49	Key West	0.54
Georgia	74.5	+ 2.7	Blakely	101	29	Clayton	39	20	5.02	+1.80	Dahlonega	9.54	Millen	1.93
Hawaii	72.2†	.....	Wailuku, Maui	93	25	Olaa Mill, Hawaii	49	4 dates	5.87‡	.....	Honomanu Val. Maui	27.60	Kihei, Maui	0.00
Idaho	51.1	.....	Garnet	94	16	Soldier	11	22	2.38	.....	Grangeville	5.21	Blackfoot	0.30
			Orofino	94	31									
Illinois	63.2	+ 0.1	St. John	94	29	Lanark	33	7	4.42	+0.36	Martinton	8.93	Benton	0.84
						St. Charles	33	1						
Indiana	63.5	+ 1.1	Bedford	95	3	Auburn	28	1	5.96	+2.05	Butlerville	10.02	Hector	3.25
			Mount Vernon	95	29									
Iowa	58.3	— 2.1	Glenwood	88	3	Washta	28	26	5.95	+1.82	Hanlontown	10.83	Bonaparte	2.57
			Wilton	88	29									
Kansas	63.1	— 1.1	Cunningham	95	1	Colby	29	17	4.54	+0.45	Columbus	8.98	Hugoton	1.37
Kentucky	68.0	+ 2.0	Jackson	95	29	West Liberty	38	1	5.23	+1.05	Scott	8.17	Loretto	2.09
			Owenton	95	28									
			Shelbyville	95	5									
Louisiana	77.4	+ 3.4	Alexandria	99	31	Ruston	48	1	5.48	+2.51	Amite	9.68	Port Eads	0.65
			Minden	99	28									
Maryland and Delaware	64.7	+ 1.6	Boettcherville, Md.	97	4	Deer Park, Md	25	21	2.99	—0.61	Solomons, Md	6.12	Bachman's Valley, Md.	0.70
						Oakland, Md	25	8						
Michigan	53.2	— 1.0	South Haven	92	4	Mancelona	14	1	4.53	+1.50	Deer Park	10.50	Mancelona	0.93
Minnesota	52.6	— 3.5	4 stations	83	4,31	Pine River Dam	11	10	5.53	+2.13	Rolling Green	8.31	Hovland	2.44
Mississippi	74.9	+ 2.4	Lake Como	98	30	Lake	41	12	5.27	+1.67	Ripley	10.50	Vicksburg	2.95
			Laurel	98	27, 30	Okolona	41	25						
			Shoccoe	98	29									
Missouri	64.9	+ 0.1	Zeitonia	94	10	Oregon	34	5	4.87	+0.03	Dean	12.03	Marshall	1.74
Montana	48.8	— 3.8	Troy	89	31	Red Lodge	8	11	2.24	—0.22	Absarokee	8.42	Alzada	0.40
Nebraska	56.2	— 3.4	Bartley	92	1	Agate	23	5, 6, 17	5.73	+2.04	Genoa	11.35	Pawnee City	2.34
Nevada	50.2	— 5.5	Sodaville	94	17	Morey	17	10	1.23	+0.49	Halleck	3.21	Beowawe	T.
New England*	54.6	— 1.5	Norwalk, Conn	86	7	Houlton, Me	22	30	1.82	—1.80	Madison, Me	3.73	Norwalk, Conn	0.69
						Van Buren, Me	22	5						
New Jersey	61.4	+ 1.0	Bridgeton	89	12, 28	Layton	22	2	1.71	—2.54	Clayton	3.94	Somerville	0.42
New Mexico	59.5	— 1.8	Carlsbad	98	27, 29	Tres Piedras	22	11	0.56	—0.47	Eagle Rock Ranch	3.66	12 stations	0.00
New York	55.1	— 0.1	Coeymans	90	15	Bouckville	18	22	2.08	—1.15	Ripley	4.70	Athens	0.41
						Paul Smith	18	25						
North Carolina	69.2	+ 2.1	Monroe, Pinehurst	90	30	Linville	31	2	6.69	+2.56	Randleman	11.40	Eagletown	2.48
			Tarboro	90	29									
North Dakota	50.1	— 2.8	Edmore	88	23	Willow City	10	4	3.05	+1.18	Wahpeton	6.29	Washburn	1.12
Ohio	60.7	— 0.6	Ironton	93	4	Greenville, Orangeville	26	21	5.63	+2.06	Cincinnati	9.52	Green Hill	3.03
			New Waterford	93	4	Wauseon	26	1						
Oklahoma and Indian Territories.	69.4	+ 0.2	Goodwater, Ind. T	94	30	Kenton, Okla	35	6	7.51	+1.38	Fort Sill, Okla	15.65	Woodward, Okla	1.13
Oregon	53.0	— 1.4	Blalock	92	30	Riverside	19	20	2.47	+0.22	Nehalem	8.59	Burns	0.53
			Grants Pass	92	15									
			John Day	92	16									
Pennsylvania	60.8	+ 0.9	Lewisburg, Lock Haven.	93	4	Pocono Lake	22	2	2.59	—1.68	Lycippus	5.17	Point Pleasant	0.56
Porto Rico	76.6	.....	Central Aguirre	98	4, 6	Adjuntas	53	11	6.78	.....	Rio Blanco	16.47	Guanica Central	1.28
South Carolina	73.4	+ 1.5	Seivern	99	30	Liberty	42	21	5.72	+2.40	Smiths Mills	9.50	Batesburg	2.95
South Dakota	53.0	— 4.4	Oelrichs	91	21	Cheyenne Agency	22	5	5.83	+3.37	Vermillion	9.51	Ashcroft	1.36
Tennessee	68.7	+ 2.7	Arlington, Union City.	93	29	Rugby	34	1	5.98	+2.25	Santa Fe	10.56	Bristol	2.20
Texas	74.8	+ 1.5	Fort McIntosh	102	25	Hereford	34	8	4.82	+0.94	Sulphur Springs	16.00	El Paso	0.03
			Fort Ringgold	102	3 dat's									
Utah	52.3	— 4.8	Utah Lake, P. S.	96	18	Coyote	18	11	1.77	+0.74	Ogden No. 2	4.25	Loa	0.10
			Rockville	96	31	Grayson	18	10						
Virginia	66.6	+ 1.8	5 stations	92	29, 30	Quantico	31	2	4.76	+0.67	Columbia	9.58	Bristol	2.20
Washington	54.2	— 1.2	Mottingers Ranch	90	30	Hatton, Republic	21	1	2.66	+0.41	Ashford	8.56	Wahluke	0.14
			Zindel	90	16									
West Virginia	64.2	+ 1.7	Sutton, Weston	96	4	Bayard	26	24	4.95	+1.11	Point Pleasant	7.96	Martinsburg	1.90
Wisconsin	53.6	— 2.9	Prairie du Chien	92	4	Koepenick	18	1	5.33	+1.64	Portage	7.64	Spooner	2.66
Wyoming	48.0	— 3.5	Basin	89	17	Little Medicine	10	5	3.18	+1.18	Fort Washakie	6.31	Evanston	0.86
			Torrington	89	31									

*Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, and Connecticut. †47 stations, with an average elevation of 508 feet. ‡131 stations.

tributed. Winter wheat and oats began to head toward the middle of the month, the heads filling well. Spring planting was vigorously prosecuted, practically all the corn being in the field by the close of the month and the transplanting of tobacco well advanced. Good stands of spring oats were secured. Minor crops, except grass for hay, did well. The outlook for fruit was not good, apples especially dropping heavily from the trees.—*Edward A. Evans.*

Washington.—Unseasonable cool weather during the first twenty-four days prevented crops from growing rapidly, but the rainfall was ample and well distributed, doing great good to all crops. Heavy frosts on several nights shortened the fruit crop nearly one-half in many localities, cut back vegetables, and even wheat in low-lying valleys. During the last week, which was warm and sunshiny, wheat and all other crops made fine progress, so that the outlook became excellent.—*G. N. Salisbury.*

West Virginia.—Owing to the wet weather during the second and third weeks, planting and cultivation were considerably retarded, but rapid progress followed during the fourth week, and planting was practically completed. At the close of the month potatoes were making good growth and gardens, sweet potatoes, millet, wheat, rye, and oats were

in good condition and doing well; the prospects were for about a half crop of apples, but were not very encouraging for cherries, peaches, pears, and plums.—*E. C. Vose.*

Wisconsin.—The weather was characterized by an excess of precipitation, especially in the southern and central counties, and a deficiency of temperature and sunshine. The continued wet weather retarded corn planting, but was generally favorable to the growth of grass and grain crops. Frosts, more or less severe, occurred in the central and northern counties, and light snow was recorded on the 8th and 9th, but no material damage resulted.—*W. M. Wilson.*

Wyoming.—The month was unusually cool, the mean temperature for the first half of the month averaging about 6° per day below the normal. The precipitation was heavy and well distributed. At the close of the month, ranges were in excellent condition, and meadows gave promise of a large crop of native hay. The cool, wet weather delayed seeding and at the close of the month, gardens, grain, and alfalfa, while looking well, were much later than usual.—*W. S. Palmer.*

SPECIAL ARTICLES.

STUDIES ON THE DIURNAL PERIODS IN THE LOWER STRATA OF THE ATMOSPHERE.

By Prof. FRANK H. BIGELOW.

IV.—THE DIURNAL PERIODS OF THE TERRESTRIAL MAGNETIC FIELD AND THE APERIODIC DISTURBANCES.

THE DIURNAL VARIATIONS OF THE TERRESTRIAL MAGNETIC FIELD.

In the years 1889–1891 I computed a series of hourly magnetic deflecting vectors for 30 stations, in polar coordinates, s = total vector, σ = the horizontal component, α = the angular altitude positive above the horizon, β = azimuthal angle counted from the north point of the magnetic meridian through the west = 90°, south = 180°, east = 270°. These were derived from the rectangular variations, ΔH horizontal force positive northward, ΔD declination positive westward, ΔV positive zenithward, by means of a simple scale diagram containing polar and rectangular coordinate systems at the same center. This presentation of the available data of observation included the diurnal variation of the magnetic field, and also the variation from day to day eliminating the hourly periodicity. The resulting tables are bulky and there has been no opportunity to publish them *in extenso*, but brief summaries of the subject matter have appeared in several places[1]. This work has aroused some critical discussion, but for the greater part of an academic character which threw little additional information upon the solution of the numerous difficult problems in solar physics and cosmical meteorology that are involved. It is quite evident that the authors of the comments did not always have in mind the details or the minor facts which must be accounted for in a final solution. It is easy to propose a vague general theory, but to bring it down to exact harmony with the many special peculiarities of the varying magnetic field is no easy problem to resolve.

In 1889 Schuster[2] published his solution for the diurnal variation of the *vertical* force derived from four stations, and ascribed to the assumed counterpart electric currents to a sensitive state of the *upper* atmosphere. In 1897 von Bezold[3] further discussed the subject as a continuation of the same data. In 1902 H. Fritsche[4] computed the variations from the difference data, ΔH, ΔD, ΔV, by means of Gaussian coefficients, and likewise attributed the magnetic effects to supposed electric currents in the upper atmosphere. In his paper of 1903, Adolph Schmidt[5] has adopted the method of deflecting vectors, and in his other papers seems to favor an electric current system in the high strata. Also, A. S. Steen[6] has worked out an elaborate system of upper air electric currents to account for the diurnal variation of the magnetic field.

Other writers, W. Sutherland, A. Nippoldt, W. van Bemmelen, J. Liznar, Carlheim-Gyllenskiöld, Ch. Chree, and L. A. Bauer seem to favor a solution of the same character.

I must confess that, aside from the entirely vague nature of this hypothesis, I have never been able to concede that it contains the true germ of the solution of the problem. That theory has received much additional popularity from the supposed bombardment of the upper strata of the earth's atmosphere by the ions ejected from the solar surface and transported to the region of the earth's orbit by the mechanical pressure of light, which were described as thereupon inducing the required electric currents. It was quite impossible to understand how such a general action of currents in the upper strata could produce the strongly localized effects observed at the surface of the earth, which so persistently follow the meteorological elements both diurnally and annually. I have, accordingly, (1) argued against the efficiency of these hypothetical upper strata electric currents to produce the details noted in the magnetic field, and I have (2) endeavored to show that the general motions of the atmosphere and the cyclonic and anticyclonic actions can not account for the observed phenomena, taken the world over, as shown by my 30-inch globe, model of 1893.

It is true that my own working hypothesis was not complete even in my own mind, and I have supposed there are steps in the series of causes and effects that still require to be added. My view was simply this, that the sun's electromagnetic or radiant field of energy falling upon the atomic and molecular constituents of the earth's atmosphere transformed them into temporary magnetic states, by polarizing some of them *in situ*, that is, throughout the strata traversed by the solar energy. These temporary magnets produced a quasi magnetic field which deflected the normal field as observed. The deflecting forces were the products of the physical processes involved in this action of the radiation upon the atoms and molecules of the atmosphere. This theory was constructed before the phenomenon of ionization of the constituents of the terrestrial atmosphere by solar radiation had been discovered, and, of course, there was little scientific material to justify my hypothesis at that time. Furthermore, after the discovery of the existence of positive (+) ions and negative (−) ions as constituents of the atmosphere had been made, it still remained impossible to match the computed magnetic deflecting forces with the pressure and temperature period of diurnal variation as observed at the *surface* of the earth. The search for conclusive evidence of the synchronism of magnetic vectors and surface temperatures and pressures was always unsuccessful, but, fortunately, this defect now seems to have been overcome by the results of the computations summarized in this present series of papers upon diurnal pressure and temperature waves in the free air above the surface within one mile of the ground. The desired synchronism seems to be so perfect as to leave little ground for further doubt that the diurnal variation of the earth's magnetic field is due to the movement of the positive (+) ions of electricity in the lower strata of the atmosphere in streams that are induced and controlled chiefly by the diurnal temperature waves that prevail in the lowest strata. I shall, accordingly, consider this paper as a supplement to chapter 4 of Bulletin No. 21. The description of the magnetic vectors there given is correct and in agreement with the systems derived by later computers, but the process of producing them, as now understood, is in accordance with the facts that have been worked out since that paper was written.

[1] Weather Bureau Bulletin No. 2, 1892. Astrophysical Journal, October, 1893. American Journal of Science, December, 1894, August, 1895. Weather Bureau Bulletin No. 21, 1898. Weather Bureau Annual Report, 1898–99, chapter 9. Eclipse Meteorology and Allied Problems, 1902, chapter 4.

[2] The Diurnal Variation of Terrestrial Magnetism. A. Schuster, 1889.

[3] Zur Theorie des Erdmagnetismus. W. von Bezold, 1897.

[4] Die Tägliche periode der Erdmagnetischen Elemente. H. Fritsche, 1902.

[5] Eine Sammlung der wichtigsten Ergebnisse erdmagnetischer Beobachtungen. A. Schmidt, 1903.

[6] The Diurnal Variation of Terrestrial Magnetism. A. S. Steen, 1904.